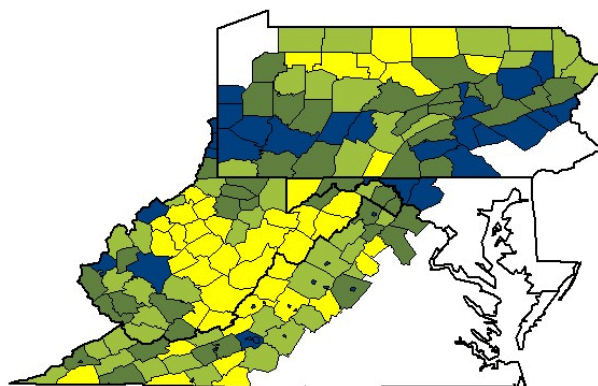
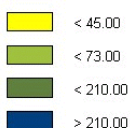


NOAA Research in the Canaan Valley

A coupling of Federal and Institutional research to explore the multi-media environmental problems of the mid-Atlantic highlands.

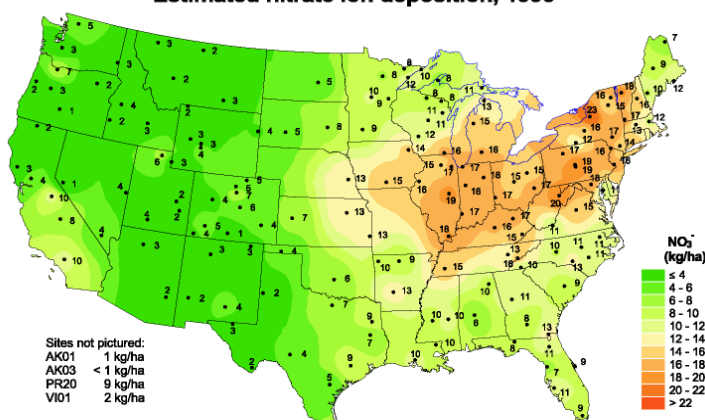
The dominant role of research in the Air Resources Laboratory (ARL) is to study processes that affect the atmosphere as a part of the global environmental system. In this, ARL has found a partner of great value in the Canaan Valley Institute (CVI). CVI is actively exploring the possibilities associated with a new approach to environmental protection. In place of the standard top down approach in which regulations are imposed from above, with the public a reluctant partner, CVI is starting with engaging the public so as to generate a ground swell with which environmental protection can be accomplished with far less pain.



The region of interest of CVI, showing population density by county. The color shadings indicate population density, in persons per square mile.

Work so far has indicated that CVI is at least partially successful in this attempt. But it is also clear that the public as a whole is unfamiliar with the details of the environmental puzzle that we are trying to solve. Discussion with the public about the role of nitrogen deposition for example, fails to ring any bells until it is pointed out that water supplies are in fact affected strongly. It is for reasons such as this that joint CVI/ARL activities are focusing on measurements and understanding of the atmosphere, the hydrosphere, and the terrestrial biosphere as they come together in an area of severe environmental stress – the Canaan Valley.

Estimated nitrate ion deposition, 1998



National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

such as atmospheric contributions to watershed acidification, the increasing frequency of occurrence of extended periods of elevated ozone concentrations, and the accelerated decay of man-made structures due to air pollution. Initial work is focused on atmospheric nitrogen and its transfer to terrestrial ecosystems.

Results obtained by the National Atmospheric Deposition Program indicate that the Canaan Valley is typically within the area of greatest atmospheric deposition of nitrate by rainfall. Based on these results, it is suspected that the Canaan Valley receives more atmospheric ammonium and nitrate than do most other locations in the USA. Yet there is only a coarse network to provide relevant data; there are no actual measurement locations in the Canaan Valley itself. Hence, the first step in

the collaboration between CVI and ARL has been to make sure the appropriate measurements are in place. To this end, stations to measure atmospheric deposition have been set up, following the NOAA AIRMoN protocols. Eddy flux measurements are also planned, to measure the evaporation rate from the area, the rate at which heat enters the atmosphere, and the rate at which the local biosphere is taking CO₂ out of the atmosphere. A SURFRAD station is now being set up, so that the total radiation balance of the area will be monitored.



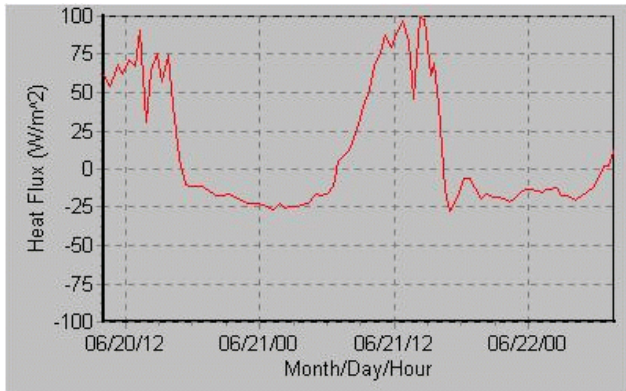
Measuring CO₂ exchange, heat and moisture exchange, and the surface wind stress in the Canaan Valley



The NOAA field site where wet and dry deposition rates are being measured. The site is in the Canaan Valley National Wildlife Refuge, under the jurisdiction of the Fish and Wildlife Service.

It is also clear that attention needs to be paid to the water quality in the same area. This is now being done. The intention is to provide a display at the CVI headquarters that includes information on both air quality and water quality variables in real time, from a location within the Canaan Valley. It is also anticipated that these data will be available in real time to outside users, such as those who plan sporting events in the area and the large recreational industry in the valley itself.

It is increasingly obvious that information of this kind is strongly sought by commercial interests in this part of West Virginia. The area as a whole has historically been one of forestry and some coal mining. At present, however, due to the decline of both of these industries, tourism is taking over as the major



Heat from the sun warms the ground during the day. Some of this heat flows into the ground itself. The remainder drives the convection that dominates the behavior of the lower atmosphere. This figure shows how the ground heat flux varies with time of day, at the Canaan Valley measurement site.

source of income. Tourism attracts people only if the environment is sufficiently clean. Residents of the Canaan Valley fear that environmental degradation will destroy their only real source of income.

The ski industry is a major source of revenue, yet there are no stations at which snow cover is accurately monitored in the region. Consequently, ARL will be installing a snow depth system alongside its SURFRAD and AIRMoN activities. Also ARL will be installing a complete energy balance system, so that this site will be part of the national CO₂ sequestration network ("AmeriFlux") and will provide information to the National Weather Service on evaporation rates and sensible heat flux. These steps are planned to take place within FY 2001, and first steps have already been taken. Full operation of the integrated measurement site may

be delayed until the beginning of FY 2002, depending upon the availability of instrumentation.

The routine measurements being made by ARL at the CVI location are not solely for the purpose of detecting trends or changes that might be attributed to some particular change in emission rates of air pollutants. They are instead strongly driven by the need to obtain an areal average addressing the health of the Canaan Valley as a whole. For this reason, there is a coupled modeling activity which is growing rapidly at this time. The Canaan Valley is seen to be a center to address air quality forecasting issues of the near future, and the measurement programs that ARL is installing there reflect this eventual goal.

To obtain the spatial averages that are truly required by any grid model requires an understanding of how the air surface exchange rates of heat, moisture, and pollutants vary across the grid cells that the model is dealing with. A measurement of a single location is indicative of the area in which the measurement is made, but cannot be assumed to represent the average across that area. Additional information is required to permit the extrapolation. In early August 2001 the NOAA Twin Otter visited the Canaan Valley, fully equipped to measure the evaporation rates, heat exchanges, and CO₂ fluxes that must be understood before this extrapolation can occur. The study in 2001 was largely exploratory. The answers obtained were tantalizing. It is clear that further study is warranted if we are ever to understand deposition from the atmosphere across regions that are topographically complex.



A Twin Otter of the NOAA fleet.

The answers necessary to address the conceptual problem of how to construct a model to describe the air surface exchange rates of the Canaan Valley rely heavily on measurements of such factors as heat and water. It is, however, the nitrogen exchange that is a key factor. This affects the water quality in the area, the biological environment, and all living systems that are down stream from the Canaan Valley catchment area. Parts of the region flow into the Chesapeake Bay, where there are readily evident signs of over-enrichment, partially caused by deposition from the atmosphere. A coupling between NOAA activities addressing the health of the Chesapeake Bay (among other east coast estuaries and bays) is being sought, with Sea Grant as an active partner.

The deposition that occurs takes place by two mechanisms, dry and wet. It is the dry deposition component that has been addressed above, in the context of the aircraft measurements. It is this that the AIRMoN-dry protocols will be reporting at the Canaan Valley site. The wet deposition component is just as important, if not more so. This can be measured, if enough care is taken, using fairly standard techniques. The AIRMoN-wet program is designed specifically to make these measurements with precision over an extended period. In the end, however, it is the total deposition that affects the environment – wet plus dry. Therefore, the spatial extrapolation of both needs to be considered. It is in the Canaan Valley where the most intensive study of this kind is presently going on. It is also in the Canaan Valley that an innovative approach to total environmental management is now being tested. It is certainly to the credit of all the parties who collaborate in this endeavor that they are investing their scarce resources to address the issues of concern, both by direct measurement and by modeling, with strong local involvement.

CVI has recently purchased a large tract of land in West Virginia, that includes a watershed seemingly ideal for calibration and future research use. The opportunity now exists for a multi-faceted research program directly addressing the question of atmospheric deposition and its migration through the terrestrial environment in a way not previously feasible.

BBH
15 March 2003